What is Claimed Is:

1. A perpendicular magnetic recording medium, comprising:

(a) a substrate of an amorphous thermoplastic polymer material having softening and glass transition temperatures as low as about 95 °C; and

(b) at least one stack of thin film layers formed on at least one surface of said substrate, said at least one layer stack including at least one granular magnetic recording layer of perpendicular type;

wherein the coercivity (H_c) of said perpendicular magnetic recording medium is at least about 4,000 Oe.

2. The medium as in claim 1, wherein:

said substrate comprises at least one amorphous thermoplastic material selected from the group consisting of: polycarbonates (PCs), polyolefins (POs), polyetherimides (PEIs), polysulfones (PSUs), and polyethersulfones (PESs).

3. The medium as in claim 1, wherein:

said substrate comprises homopolymers, copolymers, terpolymers, or blends of at least one material selected from the group consisting of polycarbonates (PCs), polyolefins (POs), polyetherimides (PEIs), polysulfones (PSUs), and polyethersulfones (PESs).

4. The medium as in claim 1, wherein:

said at least one layer stack includes, in order from said at least one surface of said substrate:

(b_1) a combined seed/adhesion layer;

(b_2) at least one soft magnetic underlayer;

(b_3) at least one non-magnetic interlayer;

(b_4) at least one granular perpendicular hard magnetic recording layer, wherein oxides and/or nitrides provide physical de-coupling between adjacent magnetic grains; and

(b_5) a protective overcoat layer.

5. The medium as in claim 4, wherein:

said combined seed/adhesion layer comprises at least one material selected from the group consisting of: a silicon nitride, Ti, Cr, Ti-Cr alloys, Cr-W alloys, Al, non-magnetic Ni-Al alloys, Mo, Nb, Ta, and other non-magnetic refractory metals;

said at least one soft magnetic underlayer comprises a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC;

said at least one non-magnetic interlayer comprises a non-magnetic material selected from the group consisting of Ru, Ti, Ru, Re, and alloys thereof;

said at least one granular perpendicular hard magnetic recording layer comprises a Co-based alloy selected from the group consisting of Co-Pt, Co-Cr, and Co-Cr-Pt; and

said protective overcoat layer comprises carbon (C).

6. The medium as in claim 5, wherein:

said combined seed/adhesion layer comprises Ti or a silicon nitride/Cr bi-layer;

said at least one soft magnetic underlayer comprises $FeCo_{30.6}B_{12.5}$;

said at least one non-magnetic interlayer comprises Ru; and

said at least one granular perpendicular hard magnetic recording layer comprises $CoPt_{18}$.

7. The medium as in claim 6, wherein:

said at least one non-magnetic underlayer comprises first and second Ru layers, said first Ru layer being adjacent said soft magnetic underlayer and sputter-deposited to a lesser thickness than said second Ru layer and in a lower inert gas pressure atmosphere than that utilized for sputter-depositing said second Ru layer.

8. The medium as in claim 1, wherein:

said at least one layer stack includes, in order from said at least one surface of said substrate:

(b_1) a combined seed/adhesion layer;

(b_2) a plurality of stacked soft magnetic underlayer/wetting layer pairs;

(b_3) a soft magnetic underlayer;

(b_4) at least one non-magnetic interlayer;

(b_5) at least one granular perpendicular hard magnetic recording layer, wherein oxides and/or nitrides provide physical de-coupling between adjacent magnetic grains; and

(b_6) a protective overcoat layer.

9. The medium as in claim 8, wherein:

said combined seed/adhesion layer comprises at least one material selected from the group consisting of: a silicon nitride, Ti, Cr, Ti-Cr alloys, Cr-W alloys, Al, non-magnetic Ni-Al alloys, Mo, Nb, Ta, and other non-magnetic refractory metals;

said plurality of stacked soft magnetic underlayer/wetting layer pairs comprises *n* stacked layer pairs, where *n* is an integer from 1 to 5, each soft magnetic underlayer comprising a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC; and each wetting layer comprising a material selected from the group consisting of Ag, Cu, Au, Ta, Cr, and alloys thereof;

said soft magnetic underlayer comprises a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC;

said at least one non-magnetic interlayer comprises a non-magnetic material selected from the group consisting of Ru, Ti, Ru, Re, and alloys thereof;

said at least one granular perpendicular hard magnetic recording layer comprises a Co-based alloy selected from the group consisting of Co-Pt, Co-Cr, and Co-Cr-Pt; and

said protective overcoat layer comprises carbon (C).

10. A method of manufacturing a perpendicular magnetic recording medium, comprising steps of:

(a) providing a substrate of an amorphous thermoplastic polymer material having softening and glass transition temperatures as low as about 95 °C; and

(b) forming at least one stack of thin film layers atop at least one surface of said substrate, said at least one layer stack including at least one granular perpendicular magnetic recording layer, wherein each of said thin film layers of said stack is formed by depositing at a substrate temperature not greater than about 70 °C, and the coercivity (H_c) of said perpendicular magnetic recording medium is at least about 4,000 Oe.

11. The method according to claim 10, wherein:

step (b) comprises sputter-depositing each layer of said at least one stack of thin film layers, wherein said at least one granular perpendicular magnetic recording layer is formed by sputtering a target in a reactive gas atmosphere including at least one of oxygen (O_2) gas and nitrogen (N_2) gas.

12. The method according to claim 10, wherein:

step (a) comprises providing a substrate comprised of at least one amorphous thermoplastic material selected from the group consisting of: polycarbonates (PCs), polyolefins (POs), polyetherimides (PEIs), polysulfones (PSUs), and polyethersulfones (PESs).

13. The method according to claim 10, wherein:

step (a) comprises providing substrate comprised of homopolymers, copolymers, terpolymers, or blends of at least one material selected from the group consisting of polycarbonates (PCs), polyolefins (POs), polyetherimides (PEIs), polysulfones (PSUs), and polyethersulfones (PESs).

14. The method according to claim 10, wherein:

step (b) comprises forming said at least one layer stack to include, in order from said at least one surface of said substrate:

a combined seed/adhesion layer;

at least one soft magnetic underlayer;

at least one non-magnetic interlayer;

at least one granular perpendicular hard magnetic recording layer, wherein oxides and/or nitrides provide physical de-coupling of adjacent magnetic grains; and

a protective overcoat layer.

15. The method according to claim 14, wherein:

said combined seed/adhesion layer comprises at least one material selected from the group consisting of: a silicon nitride, Ti, Cr, Ti-Cr alloys, Cr-W alloys, Al, non-magnetic Ni-Al alloys, Mo, Nb, Ta, and other non-magnetic refractory metals;

said at least one soft magnetic underlayer comprises a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC;

said at least one non-magnetic interlayer comprises a non-magnetic material selected from the group consisting of Ru, Ti, Ru, Re, and alloys thereof;

said at least one granular perpendicular hard magnetic recording layer comprises a Co-based alloy selected from the group consisting of Co-Pt, Co-Cr, and Co-Cr-Pt; and

said protective overcoat layer comprises carbon (C).

16. The method according to claim 15, wherein:

said combined seed/adhesion layer comprises Ti or a silicon nitride/Cr bi-layer;

said at least one soft magnetic underlayer comprises $FeCo_{30.6}B_{12.5}$;

said at least one non-magnetic interlayer comprises Ru; and

said at least one granular perpendicular hard magnetic recording layer comprises $CoPt_{18}$.

17. A perpendicular magnetic recording medium manufactured by the method of claim 16.

18. The method according to claim 16, wherein:

said at least one non-magnetic underlayer comprises first and second Ru layers, said first Ru layer being adjacent said soft magnetic underlayer and sputter-deposited to a lesser thickness than said second Ru layer and in a lower inert gas pressure atmosphere than that utilized for sputter-depositing said second Ru layer.

19. A perpendicular magnetic recording medium manufactured by the method of claim 18.

20. The method according to claim 10, wherein:

step (b) comprises forming said at least one layer stack to include, in order from said at least one surface of said substrate:

a combined seed/adhesion layer;

a plurality of stacked soft magnetic underlayer/wetting layer pairs;

a soft magnetic underlayer;

at least one non-magnetic interlayer;

at least one granular perpendicular hard magnetic recording layer, wherein oxides and/or nitrides provide physical de-coupling between adjacent magnetic grains; and

a protective overcoat layer.

21. The method according to claim 20, wherein:

said combined seed/adhesion layer comprises at least one material selected from the group consisting of: a silicon nitride, Ti, Cr, Ti-Cr alloys, Cr-W alloys, Al, non-magnetic Ni-Al alloys, Mo, Nb, Ta, and other non-magnetic refractory metals;

said plurality of stacked soft magnetic underlayer/wetting layer pairs comprises *n* stacked layer pairs, where *n* is an integer from 1 to 5, each soft magnetic underlayer of said layer pairs comprising a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC; and each wetting layer comprising a material selected from the group consisting of Ag, Cu, Au, Ta, Cr, and alloys thereof;

said soft magnetic underlayer comprises a material selected from the group consisting of Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoFeZrNb, CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeCoB, and FeCoC;

said at least one non-magnetic interlayer comprises a non-magnetic material selected from the group consisting of Ru, Ti, Ru, Re, and alloys thereof;

said at least one granular perpendicular hard magnetic recording layer comprises a Co-based alloy selected from the group consisting of Co-Pt, Co-Cr, and Co-Cr-Pt; and

said protective overcoat layer comprises carbon (C).

22. A perpendicular magnetic recording medium manufactured by the method of claim 21.